

REASONING USING NEWTON'S LAWS

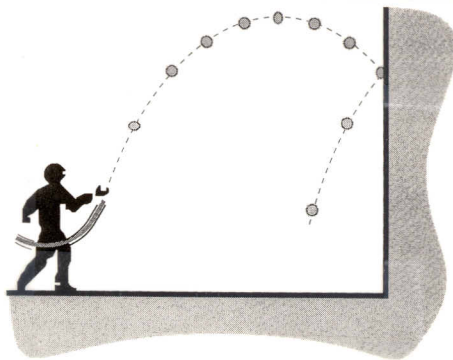
In each of the situations presented below, Newton's laws are used to provide an explanation, to predict an outcome, or to determine the forces acting on an object.

1. A horse pulls on a wagon as shown. Newton's 3rd Law states that the force exerted on the horse by the wagon must be equal and opposite to the force exerted on the wagon by the horse. Therefore, no matter how hard the horse pulls on the wagon, the wagon pulls back just as hard, making it impossible for the horse to move the wagon!



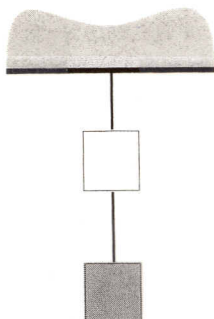
- a. Do you agree or disagree with these statements?
b. Explain.

2. Kelly throws a rubber ball against the side of her house as shown. While in contact with the house, the only forces acting on the ball are a normal force due to the house and possibly a friction force. Since the house does not move, the ball exerts no force on the house when it bounces off.



- a. Do you agree or disagree with these statements?
b. Explain.

3. Two blocks are attached to two massless strings as shown to the left. Both blocks are at rest. The FBD for the upper block is shown to the right. The three forces on the upper block are:



- (1) the gravitational force exerted by the earth on the upper block
(2) the tension force exerted by the top string, and
(3) the gravitational force exerted by the earth on the bottom block.



Do you agree or disagree with these statements? Explain.

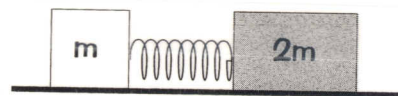
4. A father is ice skating with his daughter. The father gives the daughter a huge push, causing each of them to move in opposite directions away from their original position. However, the daughter travels faster and farther than the father does in the same amount of time. Therefore, we know that the net force on her must have been greater than the net force on the father. This is reasonable since it was the father who did the pushing. If their positions were reversed and she pushed him instead, he would travel faster and farther than she would.

Do you agree or disagree with these statements? Explain.

In the questions which follow, you are given a variety of physical situations and are asked to make comparisons of different quantities such as acceleration and force. Answer each question and explain the reasoning used. The main emphasis is on the explanation.

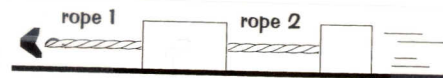
5. A spring is compressed between two blocks as shown. The surface is horizontal and frictionless. The blocks are released from rest at the same instant.

- Which block has the larger net force exerted on it just after they are released? Explain.
- Which block has the larger acceleration just after they are released? Explain.

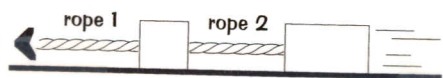


6. Two blocks are pulled to the left at a constant speed as shown. The mass of each block is proportional to its size. All the coefficients of friction are the same. Both cases are the same except that the blocks are reversed in case II.

- In which case is the normal force on the left block greater? Explain.
- In which case is the tension in rope 1 larger? Explain.
- In which case is the tension in rope 2 larger? Explain.



Case I



Case II

Now suppose that the speed of the blocks in case I is twice the speed of the blocks in case II.

- In which case is the tension in rope 1 larger? Explain.

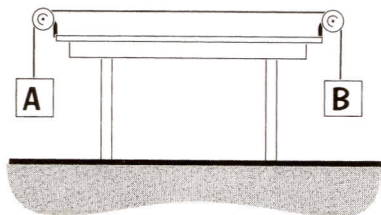
7. Consider the following three situations:

SITUATION I: Two identical blocks are hanging, one from each end of a massless string. The string passes over frictionless, massless pulleys.

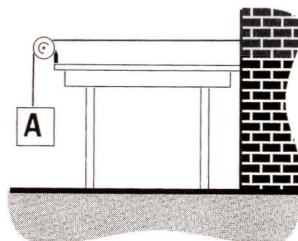
SITUATION II: A single block is hanging from one end of a massless string, which passes over a frictionless, massless pulley and is attached to a brick wall.

SITUATION III: This is the same situation as in situation I, except that now the string is broken in two places and a third block is connected to both free ends. The surface is frictionless.

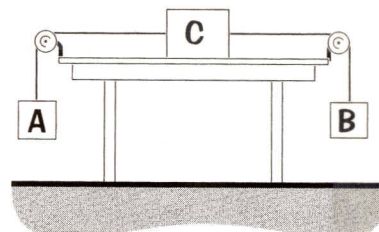
- In which situations (if any) will the system move when released from rest? Explain.
- In which of the situations is the tension in the string the largest? Explain.
- Suppose that there is friction between block C and the table. How would your answers change? Explain.



Situation I



Situation II



Situation III